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CONTENTS

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ELECTRIFICATION OF WATER AND OSMOTIC FLOW[1]

I

THE exchange of water and solutes between the cell and the surrounding fluid is one of the important factors in the mechanism of life, and a complete theory of the osmotic flow is therefore a postulate of biology. It was a marked advance when the experiments of Pfeffer and de Vries led van't Hoff to the formulation of the modern theory of osmotic pressure. According to this theory the molecules of the solute behave like the molecules of a gas in the same volume and at the same temperature, and the gas pressure of the solute measures the "attraction" of a watery solution for pure water through a strictly semipermeable membrane. Yet it is obvious to-day that in a liquid the electrical forces between solvent and solute must play a rôle and no adequate provision is made for these forces in van't Hoff's law. Traube rejected van't Hoff's theory altogether, suggesting instead that the osmotic flow was from the liquid with lower to the liquid with higher surface tension (and higher intrinsic pressure).

Tinker has shown that van't Hoff's theory for osmosis holds strictly only in the case of *ideal* solutions, *i.e.*, when the process of solution occurs without heat of dilution and change in volume, but that in the case of *non-ideal* solutions Traube's ideas explain the deviations from the gas law which are bound to occur. When two different *ideal* solutions containing equal numbers of particles of solute in equal volume are separated by a strictly semipermeable membrane, equal numbers of molecules of water will diffuse simul-

[1] Presidential address prepared for the Chicago meeting of the American Society of Naturalists, December 30, 1920.

taneously in opposite directions through the membrane and no change in volume will occur. When, however, the same experiment is made with two *non-ideal* solutions containing equal numbers of molecules in equal volume, the result is different. As Tinker has demonstrated mathematically, in this case the flow of water must be from the solution having the lower intrinsic pressure and lower surface tension to the solution with higher intrinsic pressure and higher surface tension. This is what Traube claims, and his theory explains therefore, as Tinker points out, the deviations from the gas law in the case of *non-ideal* solutions, but it does not prove that the gas law of osmotic flow does not hold in the case of *ideal* solutions and Traube's theory can not therefore replace van't Hoff's theory.

II

There is a second group of forces not taken into consideration in van't Hoff's law, namely the influence of the chemical nature of the membrane on the solvent. These forces become noticeable when the membrane separating the solution from the pure solvent is not strictly semipermeable. When water is in contact with a membrane it undergoes as a rule an electrification and this electrification of the particles of water plays a great rôle in the rate of the osmotic flow when the solution into which the water diffuses is an electrolyte.

The assumption that water diffusing through a membrane is as a rule, electrified, is justified by a large number of observations. Quincke demonstrated that when water is pressed through capillary tubes it is found to be electrically charged (the sign of charge being more frequently positive); while the tube has the opposite sign of charge, *e.g.*, negative, when the water is positively charged. When two solutions of weak electrolytes are separated by a membrane (which may be considered as a system of irregular capillary tubes) an electric current causes water to migrate to one of the two poles, according to the sign of its charge. By this method of so-called electrical endosmose it can be shown that water diffuses through collodion membranes in the form of positively charged particles. Collodion bags, cast in the shape of Erlenmeyer flasks, are filled with a weak and neutral solution of an electrolyte, *e.g.*, *M*/256 Na_2SO_4, and dipped into a beaker filled with the same solution of *M*/256 Na_2SO_4. The opening of the collodion bag is closed with a rubber stopper perforated by a glass tube serving as a manometer. When a platinum wire, forming the negative electrode of a constant current, is put through the glass tube into the collodion bag while the other pole of the battery dips into the outside solution, the liquid in the glass tube rises rapidly with the potential gradient between the two electrodes. The water therefore migrates through the collodion membrane in the form of positively charged particles. The writer has made a number of experiments[2] concerning the osmotic flow through collodion membranes, and it is the purpose of this address to give a brief survey of the results.

III

When a collodion bag is filled with a solution of a crystalloid, *e.g.*, sugar or salt, and dipped into a beaker containing pure water, the pure water will diffuse into the solution and the level of liquid in the capillary glass tube serving as a manometer will rise. At the same time particles of the solute will diffuse out of the bag (except when the solute is a protein solution or a solution of some other colloid). The concentration of a crystalloid solute inside the collodion bag will therefore become constantly smaller until finally the solution is identical on both sides of the membrane. Nevertheless the relative force with which a given solution inside the collodion bag "attracts" the pure water into which the bag is dipped can be measured by the initial rise in the level of water in the manometer, before the concentration of the solution has had time to diminish to any great extent through diffusion. Since in the

[2] Loeb, J., *J. Gen. Physiol.*, 1918–19, I., 717; 1919–20, II., 87, 173, 273, 387, 563, 659, 673.

first minutes accidental irregularities are liable to interfere with the result, we measure the rise in the level of liquid in the manometer during the first 20 minutes.

If the initial rise of level of liquid in the solution is thus measured it is noticed that it occurs approximately in proportion with the concentration of the solution when the solute is a non-electrolyte. The rate of diffusion of pure water into a solution of cane sugar through a collodion membrane is therefore approximately a linear function of the concentration of the solute within the limits of O and 1 *M*. This is what we should expect on the basis of van't Hoff's theory of osmotic pressure.

If, however, a watery solution of an electrolyte is separated from pure water by a collodion membrane, water diffuses into these solutions as if its particles were positively charged, and as if they were attracted by the anion of the electrolyte in solution and repelled by the cation with a force increasing with the valency of the ion (and another property of the ion to be discussed later).

Pure water diffuses into a *M*/128 solution of NaCl through a collodion membrane more rapidly than it diffuses into a *M*/64 solution of cane sugar; water diffuses into a *M*/192 solution of Na_2SO_4 or Na_2 oxalate still more rapidly than into a *M*/128 solution of NaCl; and into a *M*/256 solution of Na_3 citrate water diffuses more rapidly than into a *M*/192 solution of Na_2SO_4, and into a *M*/320 solution of $Na_4Fe(CN)_6$ still more rapidly than into a *M*/256 solution of Na_3 citrate. Assuming complete electrolytic dissociation of the electrolytes in these cases, the influence of the five solutions mentioned should be identical according to van't Hoff's theory. We notice, instead, that the "attraction" of the solutions for water increases with the valency of the anion. This is true for all neutral solutions of salts contained in a collodion bag, regardless of the nature of the cation.

If a collodion bag containing a neutral solution of a salt with bivalent cation, *e.g.*, *M*/192 $CaCl_2$ or $MgCl_2$, or with a trivalent cation, *eg.*, *M*/256 $LaCl_3$, is dipped into a beaker with pure water we notice no rise in the level of water in the manometer. In solutions with bivalent or trivalent cations the repulsion of the cation equals or exceeds therefore the attraction of the anion for the positively charged particles of water diffusing through the pores of the collodion membrane. Hence we conclude from these (and numerous similar) experiments that the particles of water diffuse through a collodion membrane as if they were positively charged and as if they were attracted by the anion of an electrolyte and repelled by the cation with a force increasing with the valency of the ion.

It seemed of interest to find that concentration of a cane sugar solution which just suffices to prevent the diffusion of water into a given solution of an electrolyte. Into each of a series of beakers, all containing the same neutral salt solution, *e.g.*, *M*/192 Na_2SO_4, was dipped a collodion bag containing a cane sugar solution of different concentration, from *M*/128 to 1 *M*, and it was observed in which of these sugar solutions the level in the manometer rose during the first 10 minutes, in which it fell, and in which it remained constant. It was found that the cane sugar solution which was just able to balance the

TABLE I

Approximate Concentration of a Solution of Cane Sugar Required to Balance the Osmotic Attraction of the Following Solutions of Electrolytes for Water

Molecular Concentration	Electrolyte Used	Approximate Molecular Concentration of Balancing Solution of Cane Sugar
M/128	KCl	*M*/8
M/192	K_2SO_4	Between *M*/4 and *M*/2
M/192	K_2 oxalate	*M*/2
M/192	K_2 tartrate	Slightly above *M*/2
M/256	K_3 citrate	Slightly above 3*M*/4
M/128	RbCl	*M*/4
M/128	KCl	*M*/8
M/128	NaCl	*M*/8
M/128	LiCl	Slightly above *M*/32
M/192	$MgCl_2$	*M*/64
M/192	$CaCl_2$	Below *M*/64
M/192	$SrCl_2$	Below *M*/64
M/192	$BaCl_2$	*M*/64
M/192	$CoCl_2$	Below *M*/64
M/192	$MnCl_2$	Below *M*/64

"attraction" of the $M/192$ solution of Na_2SO_4 for water had to have a concentration of about or over $M/4$. If the gas pressure effect alone determined the relative attraction of the two solutions for water the concentration of the sugar solutions required to osmotically balance the $M/192$ solution of Na_2SO_4 should have been $M/64$ (or slightly less). Hence the sugar solution balancing osmotically a $M/192$ Na_2SO_4 solution was found to be 16 times more concentrated than the theory of van't Hoff demands. This high concentration of cane sugar was needed to overcome the powerful "attractive" influence of the anions of a $M/192$ solution of Na_2SO_4 for the positively charged particles of water. Table I. shows the results of a few such experiments. The solution of the electrolyte was in these experiments always theoretically isosmotic with a $M/64$ cane sugar solution (on the assumption of complete electrolytic dissociation). The data contained in Table I. have only a qualitative value since no attempt at an exact determination of the concentration of the balancing sugar solutions was made. The data show, however, that the "attraction" of $M/128$ KCl for positively charged particles of water is eight times as great, that of K_2SO_4 sixteen times as great, and that of $M/256$ K_3 citrate almost forty-eight times as great as that of $M/64$ cane sugar; while the "attraction" of a $M/192$ solution of a salt with a bivalent cation and monovalent anion, like $MgCl_2$, for water is not greater than that of a $M/64$ solution of cane sugar.

These experiments then prove that the rate of diffusion of water from the side of pure water through a collodion membrane into a solution of an electrolyte increases with the valency of the anion and diminishes with the valency of the cation. They give also a rough idea of the relative influence of these ions upon the rate of diffusion of positively charged water through the pores of the collodion membrane from the side of pure water to the side of the solution.

A second fact brought out in these experiments was that the relative influence of the oppositely charged ions of an electrolyte in solution upon the rate of diffusion of positively charged water from the side of pure water to the side of the solution is not the same in all concentrations. Beginning with the lowest concentrations the "attractive" effect of the anion for positively charged water increases more rapidly with increasing concentration than the "repulsive" effect of the cation until the concentration of the electrolyte is about $M/256$; from then on the "repulsion" of the cation upon positively charged water increases more rapidly than the "attractive" effect of the anion. As a consequence we can say that in concentrations of neutral salts between $M/256$ and $M/8$ the "attraction" of the solution for water diminishes with increasing concentration. This is the reverse of what we should expect if the gas law alone determined the attraction of water by solutions of electrolytes. When the concentration of the solution is $M/8$, the apparent electrostatic effects of the ions upon the positively charged particles of water disappear and for concentrations above $M/8$ the curves for the attraction of water by electrolytes and by sugar solutions show less difference.

We have already mentioned the fact that the valency of the ion is not the only quantity which determines its influence on the rate of diffusion of water through a collodion membrane. In addition to the valency (or the number of electrical charges) a second quantity of the ion enters which may be designated provisionally as the influence of the radius of the ion. In the case of monovalent and monatomic cations the retarding influence on the rate of diffusion of positively charged particles of water through the collodion membrane from the side of pure water into a solution increases inversely with the radius of the ion, namely in the order $Li > Na > K > Rb$, where the retarding effect is greatest in the case of Li and least in the case of Rb; while in the case of monatomic monovalent anions the accelerating effect upon the rate of diffusion of positively charged particles of water from the side of pure water through the membrane into the

solution increases directly with the radius of the ion I > Br > Cl; where I has the greatest and Cl the smallest attractive action.

This might be intelligible if the action of the ions on the particles of water were electrostatic, since in this case the action of the anion depends on the negative charge in its outermost shell of electrons and the electrostatic effect should be the greater the farther the shell is removed from the positive nucleus of the ion; while the electrostatic effect of the cation is due to the positive charge of the nucleus and this should be the greater the smaller the distance between nucleus and the outermost layer of electrons, *i.e.*, the closer the positive nucleus can approach the water particles or the membrane particles on which the ion is to act.

IV

We have alluded to the fact that collodion membranes are not strictly semipermeable and that crystalline solutes diffuse out from the collodion flasks in our experiments. It might be argued that the differences in the flow of water measured in the preceding chapter are due to differences in the rate of diffusion of electrolytes from the side of the solution to the side of pure water through the collodion membrane. This assumption is, however, not tenable since it can be shown that the diffusion of the solutes into the pure water through the collodion membrane seems to follow Fick's diffusion law according to which the rate of diffusion of a solute is directly proportional to its concentration and this seems to hold equally in the case of electrolytes and non-electrolytes. The specific influence of solutions of *electrolytes* on the rate of diffusion of water from pure water through collodion membranes into solutions can therefore not be due to any difference in the rate of diffusion of electrolytes and non-electrolytes through the membrane into the pure water, but must be ascribed to a difference in the behavior of water towards these two types of solutes.

V

We have thus far mentioned only the influence of electrolytes on the rate of diffusion of positively charged particles of water. Perrin found in his experiments on electrical endosmosé that in certain cases the water migrated to the positive electrode, namely when the solution had an acid reaction, while it migrated to the negative electrode when the solution had an alkaline reaction. No such reversal in the sign of electrification of water can be produced in the case of pure collodion membranes, since in this case the water is always positively charged no matter whether the solution is acid, neutral, or alkaline. When, however, we deposit a film of a protein on the inside (or on both sides) of the collodion membrane the latter becomes amphoteric. When the solution is sufficiently acid, the water migrates through the membrane as if its particles were negatively charged, while when the hydrogen ion concentration is lower, *i.e.*, when the solution is only very faintly acid or neutral or alkaline, the water particles move through the protein film of the membrane as if they were positively charged.

When we separate an acid solution of a salt by a collodion membrane possessing a protein film, from a solution of a pure acid of the same hydrogen ion concentration as that of the salt solution, the hydrogen ion concentration being equal to or above 10^{-4} N, the water migrates through the pores of the membrane as if its particles were negatively charged and as if they were "attracted" by the cation and "repelled" by the anion of the electrolyte in solution with a force increasing with the valency of the ion. In this case, water is "attracted" more powerfully by salts with trivalent cation, *e.g.*, $AlCl_3$ or $LaCl_3$, than by salts with bivalent cation *e.g.*, $MgCl_2$ or $CaCl_2$; and it is "attracted" more powerfully by the latter than by salts with monovalent cation, *e.g.*, NaCl or KCl; while negatively charged water is not "attracted" by salts with bivalent or trivalent anions, *e.g.*, Na_2SO_4 or Na^4 oxalate or $Na_4Fe(CN)_6$, etc.

In the case of salts with monatomic and monovalent cations the "attraction of" the salt for negatively charged water seems to increase inversely with the radius of the

cation in the order Li > Na > K > Rb, where Li with the smallest radius "attracts" the negatively charged water most and Rb with the largest radius "attracts" the water least. The monatomic monovalent anions "repel" the negatively charged particles of water directly in proportion with the radius of the ion in the order I > Br > Cl, where I with the greatest radius "repels" the negatively charged water most, and Cl least.

The relative "attractive" and "repelling" action of the two oppositely charged ions of an electrolyte for negatively charged water is not the same in all concentrations. In the lowest concentrations the attractive influence of the cation for negatively charged water increases more rapidly with increasing concentration than does the repelling action of the anion; while beyond a certain concentration the repelling action of the anion on the negatively charged water increases more rapidly than the attractive action of the cation. Finally a concentration is reached where the electrical effects of the two oppositely charged ions balance each other more or less and from then on the solution behaves more like that of a non-electrolyte.

VI

In the course of these experiments facts were observed which indicate a chemical source for the electrification of water when in contact with a collodion membrane. We have mentioned the fact that when a membrane has been treated with a protein, the sign of the electrification of water in contact with the membrane can be reversed by acid. The protein forms a fine film on the surface and probably inside the pores of the collodion membrane. In an alkaline or neutral, and often even a very faintly acid concentration the water in contact with the protein film is positively charged, but when the hydrogen ion concentration exceeds a certain limit the water assumes a negative charge. The writer has measured the hydrogen ion concentration at which this reversal occurs and has found that it changes in a characteristic way with a certain chemical constant of the protein which constitutes the film, namely its isoelectric point. Proteins are amphoteric electrolytes which behave differently on the two sides of a hydrogen ion concentration which is termed the isoelectric point. On the alkaline side from the isoelectric point proteins behave like a fatty acid, *e.g.*, CH_3COOH, forming metal proteinates with alkalies, *e.g.*, Na proteinate. On the acid side of the isoelectric point the proteins behave like NH_3, forming protein-acid salts, *e.g.*, protein chloride. We may imagine that proteins exist in the form of two isomers, one on the alkaline side of the isoelectric point possessing COOH as the active chemical group; the other on the acid side of the isoelectric point possessing NH_2 as the chemically active group. The isoelectric point, *i.e.*, the hydrogen ion concentration at which the reversal of one type of protein salt to the other occurs, is a characteristic constitutional property of each protein. Its value is, according to L. Michaelis, a hydrogen ion concentration of $10^{-4.7}N$ for gelatin and for casein, $10^{-4.8}N$ for crystalline egg albumin, and $10^{-6.8}N$ for oxyhemoglobin.

The writer has been able to show that the reversal of the sign of charge of water when in contact with a collodion membrane possessing a protein film practically coincides with the isoelectric point of the protein used, lying slightly on the acid side of this point. The method of determining the hydrogen ion concentration at which the reversal in the sign of electrification of water occurs is as follows: We have shown that $M/64$ $CaCl_2$ or $M/256$ $LaCl_3$ "attract" negatively charged water powerfully, while these two salts do not "attract" positively charged water. On the other hand, Na_2SO_4 "attracts" positively charged water powerfully while it does not "attract" negatively charged water. We fill a series of collodion bags previously treated with a protein each with a $M/64$ $CaCl_2$ solution, and dip each collodion bag into a beaker with distilled water. The $M/64$ $CaCl_2$ solution in each bag is brought to a different hydrogen ion concentration by adding suitable quantities of HNO_3 or NaOH to the

solution; and the distilled water in the beaker is always brought to the same hydrogen ion concentration as that of the $M/64$ $CaCl_2$ solution inside the collodion bag dipped into the beaker. Similar experiments are made with Na_2SO_4 brought to a different hydrogen ion concentration. The result of these experiments is striking. There is always one definite hydrogen ion concentration at which the "attraction" of both $M/64$ $CaCl_2$ (or $LaCl_2$) as well as that of $M/256$ Na_2SO_4 for water is almost zero. As soon as the hydrogen ion concentration rises, the attraction of $M/64$ $CaCl_2$ for water becomes noticeable and increases with a further increase in the hydrogen ion concentration until it reaches a maximum (at a hydrogen ion concentration of about $10^{-3}N$). The attraction of M/256 Na_2SO_4 for water rises when the hydrogen ion concentration falls below the point where the attraction is zero. $M/256$ Na_2SO_4 attracts water when it is positively charged and $M/64$ $CaCl_2$ does so when water is negatively charged. Where neither solution "attracts" water the latter is not electrified. (It should be mentioned that the attraction of a cane sugar solution of $M/64$ or below for water is very slight and scarcely noticeable, and that this is the reason that when water is not electrified it is not noticeably attracted by $M/64$ $CaCl_2$ or $M/256$ Na_2SO_4.) Table II. shows the close relation of this hydrogen ion concentration and that of the isoelectric point for different proteins. Water begins to become negatively charged in contact with a collodion membrane as soon as the hydrogen ion concentration is slightly on the acid side of the isoelectric point of the protein forming a film on the membrane.

TABLE II

Nature of Protein Film on the Membrane	Hydrogen Ion Concentration where Water is Uncharged	Isoelectric Point of Protein
Gelatin.....	Between $10^{-4.0}$ and $10^{-4.6}N$	$10^{-4.7}N$
Casein	" " " "	$10^{-4.7}N$
Egg albumin	" " " "	$10^{-4.8}N$
Oxyhemoglobin ..	About $10^{-6.0}$ and $10^{-7.0}N$	$10^{-6.8}N$

The quantitative agreement between the isoelectric point of the protein forming the film on a collodion membrane and the point of reversal of the sign of electrification of water is such that it is difficult to question the connection between the chemical constitution of the protein and the sign of electrification of water. It is also obvious that the density of the charge varies with the hydrogen ion concentration.

When the collodion membrane is not treated with a protein the water is always positively charged and no reversal in the sign of the charge can be obtained by an increase in the hydrogen ion concentration. This harmonizes with the fact that collodion is not an amphoteric electrolyte.

It is to be expected that in addition to the chemical nature of the membrane the chemical nature of the liquid in contact with the water also influences the sign (and density) of the electrical charge at the boundary of the two phases. Indications supporting this view exist but they can not be discussed in this connection.

VII

van't Hoff's theory of osmotic pressure confronted the physiologists with the puzzling fact that in the phenomena of secretion water diffused often from places of higher to those of lower osmotic pressure. In 1908 Girard suggested that such cases of abnormal osmosis as occur in organisms might be explained on the assumption that the opposite sides of a membrane separating pure water from an acid or alkaline solution are oppositely charged, and that therefore Perrin's experiments on electrical endosmose furnish the explanation of these phenomena. According to Girard, only H or OH ions should produce such a difference in charge and neutral solutions of electrolytes should behave like solutions of non-electrolytes which is, however, not correct. Bernstein, in 1910, also reached the conclusion that electrical endosmose might be utilized for the explanation of abnormal osmosis as manifested in secretion and in his book on "Electro-Biology" many speculations in this direction are offered but unfortunately very few experiments. He also assumes that the opposite sides of the mem-

brane of a gland are oppositely charged. Under such circumstances positively charged water particles will be driven in the direction from the positive to the negative side of the membrane. As soon as the positively charged water particle reaches the negative side of the membrane it gives off its charge. This enables other positively charged water particles to follow.

Ideas similar to those offered by Girard and by Bernstein have been expressed by way of explanation of other cases of abnormal osmosis by Bartell and his collaborators, and by Freundlich.

Whatever the ultimate theory of the driving force in these cases may be, we have a right to state that the electrification of the particles of water migrating through a membrane is a fact; that the sign of this electrification seems to depend on the chemical nature of the membrane in contact with water; that the rate of migration of these charged particles of water through the membrane from the side of pure water to the side of the solution is accelerated by the ions of the opposite sign of charge and retarded by the ions with the same sign of charge as that of the water with a force increasing with the valency of the ion; and that the relative acceleration and retarding effects of the two oppositely charged ions on the rate of diffusion of electrified water are not the same for all concentrations, that in lower concentrations of electrolytes the accelerating action of the oppositely charged ion increases at first more rapidly than the retarding effect of the other ion; while for higher concentrations the reverse is the case, until finally a concentration of the electrolyte is reached where the effects of the oppositely charged ions more nearly balance each other.

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HENRY ANDREWS BUMSTEAD

My personal acquaintance with Henry A. Bumstead dates from a meeting of the British Association in Winnipeg in the summer of 1909. He had studied in Cambridge, England, where his engaging personality, keen intelligence, and unusual *savoir faire* had made him a place in the hearts and homes of English scientists which has been held by few Americans. I was then almost unknown both to him and to them, but I soon learned that if Bumstead was in any gathering I should at once feel at home.

I was walking with him one day through one of the busy streets of Winnipeg when he asked if I would not step into a shop with him while he bought a little memento for Mrs. Bumstead, a "bad habit" which he said he had formed on trips away from home.

I mention these two trivial incidents because they reveal the soul and heart of the man; and what, after all, is either science or art in comparison?

When in 1917 the important and difficult post of scientific attaché in London was created, Bumstead was the only man considered, for no scientist in this country had his tact, his judgment, his knowledge of England, and his ability to assist in bringing about what was then, and what is now, the most important need of the modern world, namely, the cooperation and mutual understanding of the two great branches of the Anglo-Saxon race.

Bumstead's success in London was extraordinary. The British liked and trusted him. Admiral Sims and our own War Department placed large responsibilities upon him, and his office became the center of a very active and very important service. Young American officers who went abroad on scientific missions found him the center of their contacts and the prime source of their usefulness. They all became his devoted admirers. Not one or two but a dozen or more of both British and American officers who came to Washington during the war told me that they owed their success in their work in England and the continent primarily to Bumstead, and counted it the most valuable part of their experience that they had had an opportunity to become acquainted with him. One of these officers de-

scribed him as the most influential American in England.

As chairman of the National Research Council, as member of the National Research Fellowship Board, and as participant in other important groups with which he was associated at the time of his death, Bumstead showed the same broad outlook, the same big human interest, the same tact, the same sane intelligence and sound judgment which had characterized his work in England.

He spent practically the whole of the holiday week at my home in attendance upon the meetings of the Physical Society and of various committees of which he was a member. He was apparently in the best of health and spirits. Indeed, he spent Friday morning, December 31, going over with me the research work of the Ryerson Laboratory, and as we chatted together before he left about future plans he remarked that since his last operation some four years ago he had been feeling in excellent condition. He left me at about 11:30, intending to take the afternoon train for Washington. The next morning Dr. Vernon Kellogg, who occupied the berth opposite him, attempted to awaken him and found that he had gone.

He leaves a big gap in the ranks of American physicists. Born just fifty-one years ago in Pekin, Illinois, and educated in the public schools of Decatur, from which he went first to Johns Hopkins and then to Yale, he had done honor to the state which gave to this country Lincoln and Grant. He had been president of the American Physical Society, director of the Sloane Physical Laboratory since 1906, a very influential member of the Yale faculty, a member of the National Academy of Sciences, and a fellow of the American Academy of Arts and Sciences. He had a brilliant analytical mind, profound scholarship, exceptional critical capacity, excellent judgment, an extraordinary winsome personality, the finest culture, and a great heart. His personal scientific contributions were important, though they had been much interferred with by his none too rugged health. His effect upon American physics, however, was not limited to his own scientific papers, but he exerted a powerful influence upon his pupils and upon his fellow physicists.

It is not merely American science, however, which can ill afford to lose him twenty years before his time. American life in all its aspects is sadly in need of men of Bumstead's type. The cause of sanity, of culture, of Anglo-Saxon solidarity, of scholarship, of science, of world civilization, all suffer irreparably through his death. R. A. MILLIKAN

SCIENTIFIC EVENTS

POLAR RESEARCH

The Christian Science Monitor reports that the Ambassador of the United States in London, Mr. John W. Davis, visited the meeting of the Royal Geographical Society held at the close of the year to discharge a pleasant duty with which he had been intrusted by the American Geographical Society of New York. When the centenary of the birth of David Livingston was celebrated in 1913, the Hispanic Society of America founded a gold medal for exploration and placed it at the disposal of the American Geographical Society. It is one of the highest awards in the geographical world, and its latest recipient is Dr. W. S. Bruce, who has devoted his life to the extension of knowledge of the Arctic and Antarctic regions. This medal was presented by Mr. Davis. In the unavoidable absence of Dr. Bruce the medal was received on his behalf by Dr. R. N. Rudmose Brown, who has served under Dr. Bruce in both the north and the south polar regions. The ceremony emphasized the close interest which the American and English peoples have taken in popular research. Mr. Davis, in making the presentation, expressed his satisfaction that the American Geographical Society had not imposed any narrow confines on their choice of a recipient; and Dr. Rudmose Brown, in returning thanks, said that Dr. Bruce's gratification at receiving the medal would be increased by the thought that it had been adjudged to him by the countrymen of such explorers as Wilkes and Greely.

The meeting at which the presentation was made was devoted to a lecture on the future of polar exploration by Frank Debenham, who served as a geologist on Captain Scott's last expedition. Several other polar explorers were present, among them Sir Ernest Shackelton and Dr. G. C. Simpson, the present director of the Meteorological Office. Mr. Debenham's lecture was a reply to the question which is so often asked: What is the good of polar exploration? He justified it on commercial, national, scientific and ethical grounds. On the first ground he claimed that the industries which had been developed as a result of Arctic and Antarctic exploration had yielded far larger returns than the cost of all the polar expeditions that ever sailed. There are world-wide problems requiring solution which can not be studied adequately without the aid of observations in the polar regions.

Mr. Debenham announced that the trustees of the Captain Scott memorial fund had decided to establish a polar research institute. It will be attached to the School of Geography at Cambridge University, anl will comprise a library, a museum, and a small set of research rooms.

ANTHROPOLOGICAL PUBLICATIONS OF THE CANADIAN ARCTIC EXPEDITION

The Arctic Board, which is a body composed of a number of scientists in the employ of the Canadian government, has been arranging for the publications of a series of scientific monographs based on the results of the Canadian Arctic Expedition, 1913–1918. The complete report is planned to take up sixteen volumes, many of which are subdivided into parts. A considerable number of the papers dealing with zoology and botany have already been issued.

The last 5 volumes of the series are to be devoted to anthropology. The complete anthropological schedule so far as it can be definitely planned at the present date is as follows:

VOLUME XII: LIFE OF THE COPPER ESKIMOS

The Life of the Copper Eskimos. By D. Jenness. (*In press*).

VOLUME XIII: PHYSICAL CHARACTERISTICS AND TECHNOLOGY OF THE COPPER ESKIMOS

Part A: The Physical Characteristics of the Copper Eskimos. By D. Jenness (in part). (*In preparation.*)

Part B: Technology of the Copper Eskimos. (*To be prepared.*)

VOLUME XIV: ESKIMO FOLK-LORE AND LANGUAGE

Part A: Folk-Lore, with Texts from Alaska, the Mackenzie Delta, and Coronation Gulf. By D. Jenness. (*In preparation.*)

Part B: Comparative Grammar and Vocabulary of the Eskimo Dialects of Point Barrow, the Mackenzie Delta, and Coronation Gulf. By D. Jenness. (*In preparation.*)

VOLUME XV: ESKIMO STRING FIGURES AND SONGS

Part A: String Figures of the Eskimo. By D. Jenness. (*Ready for press.*)

Part B: Songs of the Copper Eskimos. By D. Jenness (in part). (*In preparation.*)

VOLUME XVI: ARCHEOLOGY

Contributions to the Archeology of Western Arctic America. (*To be prepared.*)

ADMINISTRATION OF THE ALASKA FORESTS

Secretary Meredith, of the Department of Agriculture, approved the establishment on January 1 of a new National Forest District, for Alaska. This will be known as the Alaska District, with headquarters at Juneau, and will be in charge of Charles H. Flory, as district forester. Mr. Flory has been superintendent of Alaska National Forests for the past two years, with headquarters at Ketchikan. The new district headquarters will remain at Ketchikan until July 1.

Colonel W. B. Greeley, the chief forester of the Forest Service, spent some time in Alaska last summer, securing information on conditions there, and as the result of his trip recommended to Secretary Meredith the establishment of a separate National Forest District. There are two National Forests in Alaska, the Tongass in southeast Alaska and the Chugach in the Prince William Sound country. These forests are now included in the North Pacific District and are under direction of District Forester George H. Cecil, in Portland.

The Alaska National Forests now become a separate district because of their increasing importance as a source of pulp material and

mainly in order to get local administration, which the Forest Service has followed since 1908, when district headquarters were established in six western cities for the protection and administration of the national forests.

The announcement of the establishment of the new district is made at the Portland office almost simultaneously with the news from Washington that the President has authorized an Inter-Departmental Committee to coordinate federal activities in Washington having to do with Alaska. E. A. Sherman, associate forester of the Forest Service, who spent some time in Alaska, represents the Department of Agriculture on the new Alaska committee.

FISHERY MATTERS IN CONGRESS

APPROPRIATIONS for the Bureau of Fisheries for the fiscal year 1922, as carried in the sundry civil appropriation bill reported to the House of Representatives on December 29, aggregate $1,240,460, an increase of $29,150 over the appropriations for the current year. The increase is made up chiefly of additions of $12,500 for the division of fishery industries and $15,000 for the Alaska service. No new position is created except that of engineer at the Cape Vincent station, no special appropriations are made, and no increases in salaries are provided except in the case of naturalist of the steamer *Albatross*.

Congressman Esch, of Wisconsin, has introduced a bill (H. R. 14676) providing for the establishment of a fish-rescue and fish-cultural station on the Mississippi River in Wisconsin. The bill carries an appropriation of $75,000 and creates a staff of 15 persons, with annual salaries aggregating $22,800.

Senator McNary, of Oregon, has introduced a joint resolution (S. J. Res. 211) requesting the President to negotiate a treaty or treaties to protect from unnecessary destruction, through wasteful practises, devices, and methods, the salmon in waters of the Pacific Ocean off the coasts of the United States and Canada, both within and beyond the territorial limits of the two countries.

THE WASHINGTON ACADEMY OF SCIENCES

AT the annual meeting of the Washington Academy of Sciences on January 11, officers were elected for the year 1921. The board of managers for the year is as follows:

Dr. A. H. Brooks, Geological Survey, President, Member Executive Committee.

Dr. Robert B. Sosman, Geophysical Laboratory, Corresponding Secretary, Member Executive Committee.

Mr. Wm. R. Maxon, National Museum, Recording Secretary, Member Executive Committee.

Mr. R. L. Faris, Coast and Geodetic Survey, Treasurer, Member Executive Committee, Vice-president from Society of Engineers.

Dr. J. McKeen Cattell, Garrison-on-Hudson, N. Y., Non-resident Vice-president.

Professor E. B. Wilson, Mass. Inst. Tech., Cambridge, Mass., Non-resident Vice-president.

Dr. C. G. Abbot, Smithsonian Institution, Member of Board of Managers (1922).

Dr. W. F. Hillebrand, Bureau of Standards, Member of Board of Managers (1922).

Dr. L. A. Bauer, Department of Terrestrial Magnetism, Member of Board of Managers (1923).

Dr. T. Wayland Vaughan, Geological Survey, Mem- of Board of Managers (1923).

Professor H. S. Graves, 3454 Newark Street, Member of Board of Managers (1924).

Mr. Sidney Paige, Geological Survey, Member of Board of Managers (1924).

Dr. W. J. Humphreys, Weather Bureau, Vice-president from Philosophical Society.

Dr. Aleš Hrdlička, National Museum, Vice-president from Archeological Society.

Mr. N. Hollister, Zoological Park, Vice-president from Biological Society.

Dr. A. S. Hitchcock, Smithsonian Institution, Vice-president from Botanical Society.

Dr. William Blum, Bureau of Standards, Vice-president from Chemical Society.

Dr. F. B. Silsbee, Bureau of Standards, Vice-president from Electrical Engineers, Member of Executive Committee.

Mr. S. A. Rohwer, East Falls Church, Va., Vice-president from Entomological Society.

Mr. Raphael Zon, Forest Service, Vice-president from Foresters Society.

Mr. F. V. Coville, Bureau of Plant Industry, Vice-president from Geographic Society, Member of Executive Committee.

Dr. David White, Geological Survey, Vice-president from Geological Society.

Mr. Allen C. Clark, 816 14th St., Vice-president from Historical Society.

SAMUEL J. MELTZER[1]

The scientific staff of the Rockefeller Institute for Medical Research has learned with profound grief of the death of Dr. Samuel J. Meltzer. At a special meeting of the staff, held on November 12, 1920, it was resolved: That an expression be recorded of the sense of great loss which his passing away has occasioned.

Dr. Meltzer has been associated with the institute from the time of its inception. His great learning, his devotion to medical science, and his love for his fellow men continuously prompted the expenditure of his utmost effort in the causes to which the labor of the institute is dedicated. In this service he spent wholeheartedly the last sixteen years of his life, and in this service, in the fulness of his powers, he has died. He did not know how to spare himself in the devotion of his life to this great purpose.

The staff of the institute is conscious, however, not only of his service to the idea of the institute, but delights to recall the direction and purpose his inspiration gave to the development of medicine and medical research in the United States. His leadership and his contributions are second to the contributions of no other man in their significance for this generation of medical men. Dr. Meltzer's interest in humanity transcended the field of his medical activities. In the spirit of human cooperation he desired to include all men, so that there might flow, across the boundaries of nations, a desire for progress in the direction of universal ideals. These great interests were recognized, not only in this country, but in Europe as well, and gave Dr. Meltzer a unique position as a lover of his kind.

These are the thoughts which the staff desires to record. They indicate how widely the influence of Dr. Meltzer was spread, how intensely his example was appreciated here.

The staff desires to convey its profound sympathy to the family of Dr. Melzer, and in this resolution to acquaint them with a measure of the regard in which he was held. For the staff, Dr. Meltzer has not died; by the spirit of his example, he has helped to make the spirit of the institute, and this spirit will continue while the institute endures.

[1] Resolutions passed by the Scientific Staff of the Rockefeller Institute for Medical Research.

SCIENTIFIC NOTES AND NEWS

Dr. J. Norris Russell, of Princeton University, has been awarded the gold medal of the Royal Astronomical Society. Professor Russell will sail for London on January 29 to be present when the presentation is made.

Professor J. F. Kemp, of Columbia University, was elected president of the Geological Society of America, at the recent Chicago meeting.

Professor Gilbert Ames Bliss, of the department of mathematics at the University of Chicago, has been elected president of the American Mathematical Society.

Dr. James P. Southall, professor of physics in Columbia University, has been elected president of the American Optical Society.

A luncheon has been given in the Smithsonian Building in honor of the seventieth birthday of Dr. J. W. Fewkes, chief of the Bureau of American Ethnology.

Dr. Edwin Herbert Hall, Rumford professor of physics in Harvard University, will, on September 1, become professor emeritus.

At the recent Chicago meeting, the council of the American Association for the Advancement of Science directed the permanent secretary to appoint an assistant secretary, the duties of this officer being to aid the permanent secretary in the editorial and scientific aspects of the work of the association. Dr. Sam F. Trelease has been appointed assistant secretary. Dr. Trelease has recently returned to America after several years of service in the school of agriculture of the University of the Philippines at Los Baños. The assistant secretary will devote part of his time to the work of the association, being also on the staff of the laboratory of plant physiology of the Johns Hopkins University.

SAMUEL WAGNER, president of the Board of trustees of the Wagner Free Institute of Science since the death of the founder in 1885 resigned on January 18 and was elected president emeritus. Samuel Tobias Wagner, chief engineer of the Philadelphia and Reading Railway, was elected president of the board.

CHARLES E. THORNE, who has been director of the Ohio Agricultural Experiment Station since June, 1887, has been released from the directorship at his own request, but remains in charge of the station's investigations in soil fertility. Mr. C. G. Williams, agronomist of the station since 1902 and associate director since 1917, has been appointed acting director.

MR. LLOYD R. WATSON, assistant in apiculture, U. S. Bureau of Entomology, has accepted the position of apiculturist with the Division of Entomology of the Texas State Agricultural Experiment Station, made vacant recently by the resignation of Mr. H. B. Parks. Mr. Parks has accepted a position with the Texas State Honey Producers Association and is secretary of the National Honey Producers League.

THE government of Czecho-Slovakia has secured the services of Dr. Selskar M. Gunn, formerly of the Massachusetts Institute of Technology, as technical adviser to the ministry of public health and physical education. This appointment is in accordance with an official request from the ministry to the Rockefeller Foundation, with which Dr. Gunn has for the last three years served as associate director of the International Health Board, to supply them with such an adviser. Dr. Gunn has sailed for Europe en route to Prague and will remain indefinitely, although he has not severed his connection with the foundation.

DR. OSCAR KLOTZ, professor of pathology in the University of Pittsburgh Medical School, has been appointed a representative of the International Health Board of the Rockefeller Foundation for work in medical research and education in São Paulo, Brazil. It is expected that Dr. Klotz will spend a number of years in Brazil, during which time he will serve as director of a pathologic institute. He will be assisted by several Brazilian physicians who have received training in the United States.

DR. DONALD B. MACMILLAN plans to leave the United States next spring for a two- year scientific expedition to the Arctic region.

SIR ARTHUR NEWSHOLME, M.D., resident lecturer in charge of Public Health Administration, School of Hygiene and Public Health, Johns Hopkins University, will deliver the sixth Harvey Society Lecture at the New York Academy of Medicine on January 29. His subject will be "National changes in health longevity."

DR. VERNON LYMAN KELLOGG, permanent secretary of the National Research Council, recently gave, under the Charles K. Colver Fund at Brown University, three lectures on "Human life as a biologist sees it." These lectures were delivered on January tenth, seventeenth and twenty-fourth.

DR. KENNETH E. MEES, director of the research laboratory of the Eastman Kodak Company, gave, last week, an illustrated lecture on "Color photography," at Cornell University.

PROFESSOR DOUGLAS W. JOHNSON, of Columbia University, who was chief of the Division of Boundary Geography on the American Commission to Negotiate Peace, addressed the *Public Ledger* forum on the Peace Conference at the Academy of Music in Philadelphia, January 7, on the subject of "Fiume and the Adriatic problem." Professor Johnson is also delivering a series of four illustrated lectures on "The rôle of geography in world affairs," before the Columbia Institute of Arts and Sciences in New York City.

PROFESSOR EDGAR JAMES SWIFT, head of the department of psychology and education in Washington University, has been invited by the administrative officers of the post graduate school of the United States Naval Academy at Annapolis to repeat the lectures which he gave before the officers and students last spring. Professor Swift will lecture on "Thinking and acting," on February 19, and on "The psychology of managing men," on April 9.

A CEREMONY was held at the Massachusetts Institute of Technology on the first anniversary of the death of Richard Cockburn Mac-

laurin, formerly president. Reginald H. Smithwick, of Boston, president of the senior class and chairman of the Institute Committee, placed a wreath on the memorial which has been erected in memory of Dr. Maclaurin in the lobby of the Walker Memorial building.

We learn from the *Journal* of the Washington Academy of Sciences that Mr. Ralph W. Howell, geologist with the U. S. Geological Survey, was killed by native raiders in Beluchistan in the latter part of November, 1920. He was engaged at the time in oil exploratory work for Pearson & Son, of London, and was working near the Beluchistan-Punjab border in an area that had been considered safe from bandits. Mr. Howell was born in 1886, and had been a member of the Survey staff since 1913. He was granted leave of absence from the survey in October, 1919, to engage in private work.

On December 21, at a conference between representatives of the Department of Commerce and the Department of Agriculture held in the office of the secretary of commerce, the Bureau of Chemistry of the Department of Agriculture made known its willingness to withdraw from future investigations of fishery products, and at the same time agreed to ask Congress to transfer to the Bureau of Fisheries the item for fish investigations included in the pending estimates for the Department of Agriculture for the fiscal year beginning July 1, 1921.

UNIVERSITY AND EDUCATIONAL NEWS

The faculty of Mount Holyoke College has voted to raise a fund of $100,000 to endow the president's chair in recognition of Miss Mary E. Woolley's twenty years' service as president of Mount Holyoke.

The first Congress of the Universities of the British Empire was held in London in 1912 when all, to the number of fifty-three, were represented. It was decided to hold the congresses every five years, but the war made it impossible to do so in 1917. The second congress will accordingly be held in the summer of 1921. The number of British universities has in the meantime increased to fifty-eight.

Professor Eugene Taylor, of the University of Wisconsin, has been appointed head of the department of mathematics at the University of Idaho.

Doak B. Carrick has been elected professor of pomology, and Arno H. Nehrling assistant professor of floriculture in the college of agriculture, Cornell University.

Professor Edwin T. Hodge, head of the department of mining geology in the University of British Columbia, has joined the department of geology of the University of Oregon.

The *Bulletin* of the American Mathematical Society states that in the faculty of sciences of the University of Paris, the following changes have been made: Dr. Emile Borel, professor of the theory of functions, has been appointed professor of the calculus of probabilities and mathematical physics, as successor to Professor B. J. Boussinesq, who has retired; Dr. Paul Painlevé, professor of rational mechanics, has been appointed professor of analytical and celestial mechanics, as successor to Professor Paul Appell; Professor Elie Cartan succeeds Professor Painlevé in the chair of rational mechanics, and Professor Ernest Vessiot, recently appointed assistant director of the Ecole normale supérieure, succeeds Professor Cartan in the chair of the differential calculus; Dr. J. Drach has been appointed professor of general mathematics, and Dr. Paul Montel maître de conférences in mathematics.

DISCUSSION AND CORRESPONDENCE

A METEOR FALL IN THE ATLANTIC

It may be of interest to put on record the subjoined account of a fall of meteorites, that was reported in the *New York Times*, of November 5, 1906, a clipping from which paper I have just come across. The fall was observed from the Phoenix Line steamship "St. Andrew," en route from Antwerp to New York, on October 30, 1906, "about 600 miles northeast of Cape Race." The more

important parts of an interview with Chief Officer V. E. Spencer are here given.

On Tuesday (October 30) afternoon the weather was clear and bright, although there was little sunshine. Just after one bell, 4.30 o'clock, I saw three meteors fall into the water dead ahead of the ship, one after another at a distance of about five miles. Although it was daylight they left a red streak in the air from zenith to the horizon.

Simultaneously the third engineer shouted to me. I then saw a huge meteorite on the port beam falling in a zigzag manner less than a mile away to the southward. We could distinctly hear the hissing of the water as it touched. It fell with a rocking motion, leaving a broad red streak in its wake. The meteor must have weighed several tons, and appeared to be from 10 to 15 feet in diameter. It was saucer-shaped, which probably accounted for the peculiar rocking motion.

When the mass of metal struck the water the spray and steam rose to a height of at least forty feet, and for a few moments looked like the mouth on a crater. If it had been night the meteor would have illuminated the sea for fifty or sixty miles. The hissing sound, like escaping steam, when it struck the water, was so loud that the Chief Engineer turned out of his berth and came on deck, thinking the sound came from the engine room.

Captain Russ, of the Hamburg-American steamer *Brazilia*, which arrived about the same time as the *St. Andrew*, reported having seen a large meteor at 7 P.M. on October 30, in Lat. 47° N., and Lon. 48°W. This is believed to have been a part of the intermittent meteoric shower observed by the *St. Andrew* earlier in the evening.

In this account, by an intelligent observer, and one presumably fitted by training and profession to observe rapidly, some points of special interest may be noted: the peltoid form, zigzag path, and rocking motion, it being noteworthy that the irregular path was maintained in spite of the very large size (probably overestimated) and great weight; the probably constant general orientation, ("Brustseite"); the brilliant light, though it is not stated whether this came from the meteor or from its track; the loudness of the hissing sound when it struck the water, sufficient to rouse the Chief Engineer a mile away. One is inclined to think that the meteorites were siderolites. It is, of course, purely conjectural whether the meteor reported by the *Brazilia* belonged to the *St. Andrew* shower; the difference in time would seem to be incompatible with this supposition, which may be put down to a reporter's love of the sensational.

HENRY S. WASHINGTON
GEOPHYSICAL LABORATORY,
CARNEGIE INSTITUTION OF WASHINGTON

MUSICAL NOTATION

TO THE EDITOR OF SCIENCE: In the September number of *The Scientific Monthly* Professor E. V. Huntington describes a new way of writing music, which for simplicity and clearness can hardly be surpassed. It consists in using the ordinary staff for the twelve notes of the tempered chromatic scale, instead of (as now done) for the seven notes of the diatonic scale. This new "normalized" notation does away with all sharps and flats. Since there are just twelve lines and spaces (including the added line below) in each staff, each letter will have always the same position on the staff, whether soprano, alto, tenor or bass. It is hoped that teachers will take advantage of the normalized notation to smooth out the road for beginners, particularly in the grade schools.

There is another unnecessary musical difficulty in the way of piano students, which can be easily removed. The pupil must now become familiar with twelve different modes of fingering, one for each of the twelve possible keynotes. This means that for the average pupil so much practise is required in order to become reasonably expert at the piano that he or she becomes discouraged. In any case a great deal of time is wasted in practising the twelve sets of finger exercises.

A very slight change in the keyboard will reduce the sets of fingering from twelve to two. The change consists in having six white keys and six black (instead of seven white and five black) in each octave. The key C, which would then be black, should be fluted or corrugated on its upper surface, so as to be easily recognizable both by sight and

by touch; and there should be a roughening or a longitudinal corrugation on F sharp, the middle note of the scale, for the same purpose.

A third advantage would result from these two changes. The lines on the staff, in the normalized notation, correspond to the black keys on the normalized keyboard; and the spaces of the staff to the white keys. If the page be turned so that the left side becomes the top the correspondence is perfect, each written note on the staff having its corresponding place on the keyboard. The physiological reflex between eyes and fingers to be established by the learner thus becomes as simple and direct as it is possible to make it. The time required to become moderately expert in sight reading and playing would then be reduced at least to half what it is now.

T. P. Hall.

Vancouver, B. C.

PULSATION OF A CAT'S HEART AFTER DEATH

An interesting case of prolonged beating of a cat's heart after death came to the writer's attention a short time since. A cat was killed by the use of ether at 2:20 P.M. A short time afterwards the body was stretched on a window-sill out of doors where it stayed undisturbed, and to all appearances dead, until 3:30, when it was taken in to the laboratory and immediately skinned, and the thorax cut open exposing the pericardium and lungs. The student doing the dissecting, Mr. John M. Long, at once called the writer's attention to the fact that the right auricle (only) was beating in almost perfect rhythm, and with apparently considerable strength. This continued with only slight variation in rhythm until 3:56, when a small quantity of normal salt solution was poured over the pericardium. Beginning at this time, the pulsations began to lose their rhythm until at 4:03 the auricle was beating at the rate of three pulsations at normal speed followed by an interval of fourteen seconds, then again three beats, followed by the interval, and so on, both the heats and intervals being very regular. This continued for four minutes (until (4:07), when the number of pulsations was reduced to two instead of three, and the length of the interval began to vary from thirteen to eighteen seconds. More salt solutions was poured over the pericardium at this time, and at 4:18 the inferior vena cava was cut just above the diaphram. No change in the regularity of the pulsations was noticed from that recorded at 4:07 until the organ abruptly stopped beating at 4:44 P.M.

This gives a total length of time from the administration of the ether until the heart stopped beating of two hours and twenty-four minutes. Of course there must be subtracted a short period at the first when the cat was dying, but this still leaves something over two hours during which the auricle continued to beat after the death of the animal. During all this time no contraction was noticed in any part of the heart other than the right auricle. The pericardium was not opened until after the heart had ceased to beat. No electrical or mechanical means were used to stimulate the heart in any way, except the application of normal salt solution, as above mentioned. So far as the writer knows, this is the longest case on record of a cat's heart continuing to pulsate after death.

Horace Gunthorp

University of Washington,
Seattle, Wash.

STOCK CULTURES OF A PROTOZOON

During the course of investigation with Protozoa, a rather convenient and easy method of obtaining and keeping stock cultures of Colopoda was found.

Colopoda, as is well known, usually occur early in soil cultures from which they can be obtained, in the active state, in large numbers. Later in the life of the culture the animals encyst and it is upon this condition that the following method is based.

From a young soil culture active Colopoda are isolated, transferred to syracuse watch glasses and ordinary hay infusion added. After one or two days the culture fluid in the watch glass is allowed to evaporate slowly by leaving exposed to the air. During this slow

evaporation the animals encyst. The dried-up culture is left exposed for one or two days, when new hay infusion is added. The animals, having divided within the cysts, revive and are found in greatly increased numbers. This drying-up process can be repeated until a more or less concentrated culture of the organisms is obtained. The concentrated culture of organisms is then pipetted into a petri dish in which a piece of ordinary filtered paper, cut so as to exactly cover the bottom of the dish and moistened with hay infusion, is placed. The petri dish is then left uncovered to slowly evaporate. The filter paper, with the encysted organisms on it, when thoroughly dry can be cut into small pieces and kept indefinitely.

To start fresh cultures, pieces of the filter paper are put into watch glasses or other containers and hay infusion added. In a short time the animals revive and new cultures of the original are thus obtained.

This method of keeping stock cultures seems to be especially adapted for schools and colleges where only a limited amount of time is devoted to the Protozoa and where no time for the ordinary culture preparation work is available.

JOSEPH H. BODINE

ZOOLOGICAL LABORATORY,
UNIVERSITY OF PENNSYLVANIA

QUOTATIONS

THE BRITISH COMMITTEE FOR AIDING MEN OF LETTERS AND SCIENCE IN RUSSIA[1]

WE have recently been able to get some direct communication from men of science and men of letters in North Russia. Their condition is one of great privation and limitation. They share in the consequences of the almost complete economic exhaustion of Russia; like most people in that country, they are ill-clad, underfed, and short of such physical essentials as make life tolerable.

Nevertheless, a certain amount of scientific research and some literary work still go on. The Bolsheviks were at first regardless, and even in some cases hostile, to these intellectual workers, but the Bolshevik government has apparently come to realize something of the importance of scientific and literary work to the community, and the remnant—for deaths among them have been very numerous—of these people, the flower of the mental life of Rusia, has now been gathered together into special rationing organizations which ensure at least the bare necessaries of life for them.

These organizations have their headquarters in two buildings known as the House of Science and the House of Literature and Art. Under the former we note such great names as those of Pavlov the physiologist and Nobel prizeman, Karpinsky the geologist, Borodin the botanist, Belopolsky the astronomer, Tagantzev the criminologist, Oldenburg the Orientalist and permanent secretary of the Petersburg Academy of Science, Koni, Bechterev, Satishev, Morozov, and many others familiar to the scientific world.

Several of these scientific men have been interviewed and affairs discussed with them, particularly as to whether anything could be done to help them. There were many matters in which it would be possible to assist them, but upon one particular they laid stress. Their thought and work are greatly impeded by the fact that they have seen practically no European books or publications since the Revolution. This is an inconvenience amounting to real intellectual distress. In the hope that this condition may be relieved by an appeal to British scientific workers, Professor Oldenburg formed a small committee and made a comprehensive list of books and publications needed by the intellectual community in Russia if it is to keep alive and abreast of the rest of the world.

It is, of course, necessary to be assured that any aid of this kind provided for literary and scientific men in Russia would reach its destination. The Bolshevik government in Moscow, the Russian trade delegations in Reval and London, and our own authorities have therefore been consulted, and it would appear that there will be no obstacles to the transmission of this needed material to the House of Science and the House of Literature and Art. It can be got through by special facilities even

[1] From *Nature*.

under present conditions. Many of the publications named in Professor Oldenburg's list will have to be bought, the costs of transmission will be considerable, and accordingly the undersigned have formed themselves into a small committee for the collection and administration of a fund for the supply of scientific and literary publications, and possibly, if the amount subscribed permits of it, of other necessities, to these Russian *savants* and men of letters.

We hope to work in close association with the Royal Society and other leading learned societies in this matter. The British Science Guild has kindly granted the committee permission to use its address.

We appeal for subscriptions, and ask that cheques should be made out to the Treasurer, C. Hagberg Wright, LL.D., and sent to the British Committee for Aiding Men of Letters and Science in Russia, British Science Guild Offices, 6 John Street, Adelphi, London, W.C.2.

Montague of Beaulieu,
Ernest Barker,
E. P. Cathcart,
A. S. Eddington,
I. Gollancz,
R. A. Gregory,
P. Chalmers Mitchell,
Bernard Pares,
Arthur Schuster,
C. S. Sherrington,
A. E. Shipley,
H. G. Wells,
A. Smith Woodward,
C. Hagberg Wright.

SPECIAL ARTICLES

STAR-TIME OBSERVATIONS WITH AN ENGINEER'S Y-LEVEL

Desiring a check on a pendulum clock belonging to the Physics Department of the University of the Philippines. independent of the time-ball of the Manila Observatory, I have been led to use the following makeshift device.

In Fig. 1, O is the objective of an engineer's Y-level; B_1 a wooden block fitted over the objective, with a hole bored through; B_2 a small piece of board nailed to the block B_1; P is a 45° 1-inch prism fastened to B_1; L is

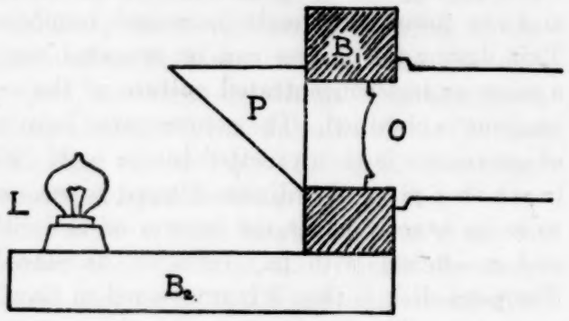

Fig. 1.

a small electric lamp. The whole attachment is tilted forward a little so that when the axis of the telescope is horizontal axial rays do not come by reflection from the zenith, but from a point about 2°or 3° from the zenith. Stray light from the little lamp L illuminates the fields so that the cross hairs are clearly seen. Two somewhat stale dry cells on the floor give enough light, but not so much as to drown the image of a fourth magnitude star. A small switch is included in the circuit.

When the instrument is set up and levelled, with no current on, the images of stars about 2° to 4° from the zenith are seen in different parts of the field; if the telescope is rotated about the vertical axis these images describe arcs of circles across the field, Fig. 2. If these arcs have horizontal chords from side to side of the circular field, Fig. 3, the prism is adjusted, *i.e.*, the rays coming down to the prism, their reflections into the telescope, and the vertical axis of rotation are in the same

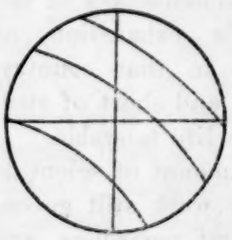

Fig. 2.

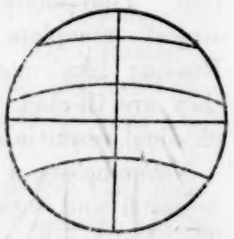

Fig. 3.

plane. This adjustment is convenient, but can not be made very exact; it is done by

twisting B_1 around the objective mounting, and noting the results. As the field is dark, quite faint stars serve.

Before use the level was carefully calibrated.

An observation is made by setting the telescope, pointing east, so that the image of a known star passes the intersection of the cross-hairs, starting a stopwatch, stopping the watch by a clock, reading both ends of the bubble; then pointing west and repeating. This gives the instants of two passages of the star across a small horizontal circle of about 2° or 3° radius; the mean of these is the clock time of transit over the meridian. If there is a change in level reading, this is allowed for by the formulas for the method of equal altitudes, *e.g.*, Comstock's "Field Astronomy," par. 64, equations (108) and (109). As but one star is used, the correction terms depending on declination vanish. Of course the best results are obtained with stars which pass very near the zenith, they being very near the prime vertical. The computations are almost as simple as those with a meridian transit instrument. With the arrangement used, the interval between upward and downward passages is about 16 minutes.

At Manila ten or twelve of the ten-day stars in the American Ephemeris are bright enough and culminate near enough to the zenith for this apparatus. I have made a good many trials, of which a large number were unsatisfactory, the concrete sidewalk on which the tripod stood, and on which I had to move about from one sighting or reading position to another, not being stable enough. However, a position was found where the bubble moved from this cause only an uncertain fraction of a division, and the results in the table were there obtained.

The columns marked "corrections for star time—time-ball time" give the corrections to be added to the time-piece reading, found as above, to give the standard mean time (E. 120°), computed from the geographical position (known to 0.1 sec.), and the star tables, or the same interpolated from the noon-time fall of the Manila Observatory time-ball. As is to be expected, the latter correction is generally found to be smaller, for the time-ball has to drop a short distance for its motion to be perceived.

Taking into consideration the clumsiness of the attachment, the uncertainties of stopwatch readings, the instability of the platform and the inexperience of the observer, the table indicates that under better conditions the method would be exact. It has the great advantage that highly accurate adjustments of collimation axis, etc., are unimportant. It can be extended by observing pairs of stars to give latitude as well as time.

TABLE I

		Correction for		
		Star Time	Time-ball Time	Dif.
1919, XI., 4 ..	γ Pegasi	− 6.95	− 7.5	+0.55
1919, XI., 4 ..	η Piscium	− 6.7	− 7.3	+0.6
1919. XI., 5 ..	γ Pegasi	− 6.4	− 8.2	+1.8
1919, XI., 5 ..	η Piscium	− 7.0	− 8.2	+1.2
1919, XI., 8 ..	γ Pegasi	−10.1	−10.7	+0.6
1919, XI., 9 ..	α Pegasi	+16.8	+16.1	+0.7
1919, XI., 9 ..	γ Pegasi	+17.1	+16.1	+1.0
1919, XI., 9 ..	η Piscium	+16.7	+16.1	+0.6
1919, XI., 9 ..	σ Arietis	+16.1	+16.1	+0.0

WILLARD J. FISHER
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MANILA, P. I.

THE AMERICAN SOCIETY OF NATURALISTS

THE thirty-eighth annual meeting of the American Society of Naturalists was held in Ida Noyes Hall and Mandel Hall, University of Chicago, December 30 and 31, 1920.

At the business meeting the treasurer's report was read, showing a balance of $514.09 in the treasury.

On recommendation of the executive committee, the constitution was amended by adding a sentence to the end of Section 1 of Article II. This section now reads:

Section 1. Membership in this society shall be limited to persons professionally engaged in some branch of natural history, as, instructors in natural history, officers of museums and other scientific institutions, physicians, and others, who have essentially promoted the natural history sciences by original contributions of any kind. Any member may present to the executive committee of the society, through the secretary, names of candidates

for membership, and those candidates who are approved by the committee may be elected to membership in the society by a majority of the members present at any meeting of the society. A nomination for membership in the society shall remain in the hands of the executive committee for at least one year before action is taken upon it. The names of candidates not elected to membership within three years of the date of consideration shall be removed from the list of nominees unless renominated.

Professor H. H. Bartlett, University of Michigan, was elected to represent the society on the board of control of Botanical Abstracts, to succeed Professor E. M. East. Dr. J. Arthur Harris is the other representative of the society on the board of control.

Professor Leon J. Cole was elected to membership for a term of five years, in the advisory committee of the society, related to the committee on cooperation and coordination of the Division of Biology and Agriculture of the National Research Council, to succeed Dr. A. G. Mayor. The other members of this advisory committee are Bradley M. Davis (4 years, chairman), Ross G. Harrison (3 years), George H. Shull (2 years), and H. S. Jennings (1 year).

The report of the committee on genetical form and nomenclature, authorized at the 1919 meeting of the society, was read, in the absence of the chairman, Dr. C. C. Little, by Dr. Sewall Wright. The society voted to continue the committee and to request it to publish the report in Science, but deferred discussion of and action upon the report to a later meeting.

The following persons, recommended to the society by the executive committee for election to membership, were duly elected: William H. F. Addison, Roy E. Clausen, Theodore D. A. Cockerell, Frederick V. Coville, George W. Crile, John W. Gowen, A. L. Hagedoorn, Duncan Starr Johnson, William Allen Orton, Charles Vancouver Piper, Harold H. Plough, Brayton Howard Ransom, Mary B. Stark, George L. Streeter, Walter T. Swingle.

The nominating committee presented candidates for vacancies in the offices of president, vice-president and treasurer, who were unanimously elected by the society. Accordingly, the officers for the year 1921 are as follows:

President: Professor Bradley M. Davis, University of Michigan.

Vice-president: Professor Henry E. Crampton, Columbia University.

Secretary: Professor A. Franklin Shull, University of Michigan.

Treasurer: Dr. J. Arthur Harris, Carnegie Institution of Washington.

Additional members of executive committee by virtue of previous office: Professor W. E. Castle, Harvard University; Professor E. M. East, Harvard University; Dr. Jacques Loeb, Rockefeller Institute for Medical Research.

The annual dinner of the society was held at the Hotel Sherman, at 7 o'clock, December 30, with one hundred and thirty-nine in attendance. In the absence of the president, Dr. Jacques Loeb, the after-dinner addresses were made by two charter members, Professors William North Rice and J. Sterling Kingsley, who narrated the story of the foundation and early days of the society.

The program of papers, which occupied Thursday and Friday, December 30 and 31, was as follows:

Thursday morning:

The analysis of a continuously varying character in the wasp Hadrobracon: P. W. Whiting.

Fluctuations of sampling in a population showing linkage: J. A. Detleesen.

Linkage between flower color and stem color in Œnothera: George H. Shull. (Read by title.)

The inheritance and linkage relation of shrunken endosperm in maize: C. B. Hutchison (introduced by R. A. Emerson).

Relative frequency of crossing-over in microspore and megaspore development in maize: R. A. Emerson and C. B. Hutchison.

Types of mutation and their possible significance in evolution: A. F. Blakeslee.

Linkage of tunicate ear and sugary endosperm and their genetic relations to other maize characters: W. H. Eyster (introduced by R. A. Emerson).

A case of maternal inheritance in maize: E. G. Anderson and L. F. Randolph (introduced by R. A. Emerson).

I. *Genetic aspects* (Dr. Anderson). II. *Cytological relations* (Mr. Randolph).

Thursday afternoon: Symposium on *General Physiology.*

On the photochemistry of the reactions of animals to light: Selig Hecht.

The influence of internal secretion on the development and growth of amphibians: E. Uhlenhuth.

The rôle of the hydrogen ion concentration in life phenomena: Wm. Mansfield Clark.

The mechanism of injury and recovery of the cell: W. J. V. Osterhout.

Enzyme action as exemplified by pepsin digestion: John H. Northrop.

The equilibrium functions of the internal ear: S. S. MAXWELL.

Friday morning:

Differential survival of male and female dove embryos in increased and decreased pressures of oxygen: a test of the metabolic theory of sex: OSCAR RIDDLE.

A decrease in sexual dimorphism during the course of selection with inbreeding: CHARLES ZELENEY.

A dominant color mutation of the guinea-pig: SEWALL WRIGHT.

Some conclusions regarding the influence of the endocrine glands upon amphibian development: BENNET M. ALLEN.

Chromosomes and the life cycle of Hydatina senta: A. FRANKLIN SHULL.

Inheritance of eye-defects induced in rabbits: M. F. GUYER AND E. A. SMITH.

The bearing of Mendelism and mutation on the theory of natural selection: C. C. NUTTING.

The inheritance of size in rats: HEMAN L. IBSEN.

Inheritance of a secondary sexual character and the effects of lethal factors in Colias philodice: JOHN H. GEROULD. (Read by title.)

A recessive mutation in haemolymph pigment in Colias philodice: JOHN H. GEROULD. (Read by title.)

Duplicate factors for cotyledon color in soy beans: C. M. WOODWORTH (introduced by J. A. Detlefsen).

Some variation in color pattern of mammals: LEON J. COLE AND JESSIE MEGEATH.

Inheritance of checks and bars in pigeons: SARAH V. H. JONES (introduced by Leon J. Cole).

Friday afternoon:

Selective fertilization and the rate of pollen tube growth: D. F. JONES.

Genetic studies in Crepis: E. B. BABCOCK.

A quantitative study of mutation in the second chromosome of Drosophila: H. J. MULLER.

A genetic analysis of "low crossover stock" produced by selection: ELMER ROBERTS (introduced by J. A. Detlefsen).

The inheritance of small deviations from bilateral symmetry: F. B. SUMNER. (Read by title.)

Relation between chaff color and pubescence in a cross between wheat and emmer: H. H. LOVE. (Read by title.)

The mutant type "crossveinless" in Drosophila virilis and D. melanogaster: ALEXANDER WEINSTEIN AND C. B. BRIDGES.

A. FRANKLIN SHULL,
Secretary

THE AMERICAN SOCIETY OF ZOOLOGISTS

THE American Society of Zoologists held its eighteenth annual meeting at the University of Chicago in conjunction with Section F of the American Association for the Advancement of Science and in association with other biological societies on December 28, 29 and 30, 1920.

Due the absence of the secretary, H. V. Neal was elected secretary *pro tem.*

The Constitution was amended by adding a new type of membership as follows:

Foreign zoologists, not members of this Society, may be elected Honorary Fellows upon unanimous recommendation of the Executive Committee by a majority vote of the members present at any meeting of the Society. Honorary Fellows shall not be required to pay dues.

The By-Law providing for affiliation with the American Society of Naturalists was amended to eliminate this affiliation.

The following were elected to membership in the Society: Royal N. Chapman, University of Minnesota; James Arthur Dawson, Dalhousie University; Leslie Clarence Dunn, Connecticut Agricultural Station; Ernest Melville DuPorte, MacDonald College; Charles McLean Fraser, University of British Columbia; William Marion Goldsmith, Southwestern College; Norman McDowell Grier, Washington and Jefferson College; Selig Hecht, Creighton Medical College; Walter N. Hess, DePauw University; Minna E. Jewell, Milwaukee-Downer College; Thestle T. Job, Loyola University School of Medicine; Rokusaburo Kudo, University of Illinois; Ralph S. Lillie, Department of Pure Science, Nela Research Laboratories; William A. Lippincott, Kansas State Agricultural College; Henry G. May, Rhode Island State College and Agricultural Experiment Station; Irene McCullough, Sophie Newcomb College; Richard Anthony Muttkowski, University of Idaho; J. M. D. Olmstead, Toronto University; Thomas Elliott Snyder, Bureau of Entomology U. S. Department of Agriculture; Wilbur Willis Swingle, Yale University; Charles Vincent Taylor University of California; Clarence Lester Turner, Beloit College; Asa Orrin Weese, University of New Mexico.

Among other items the secretary reported the death of two members, E. L. Michael and George D. Allen. The membership roll before the election of new members contained 305 names of members in good standing. The American Association for the Advancement of Science had recognized election to membership in the society as a certification of eligibility for Fellowship in the association.

The report of the treasurer showed a probable balance for January 1, 1921, of $890.30, a net increase for the year of $80.71.

The officers elected for 1921 are: *President,* C. A. Kofoid; *Vice-president,* A. L. Treadwell; *Member of the Executive Committee to serve five years,* Gilman A. Drew; *Member of Division of Biology and Agriculture, National Research Council, to serve three years,* William Patten; *Members of the Council of the American Association for the Advancement of Science,* C. C. Nutting and W. C. Allee; *Members of the Advisory Board to serve four years,* C. A. Kofoid and D. H. Tennent.

Professor R. A. Budington appealed for support for Professor Van der Stricht and his *Archiv de Biologie* which can be given by the purchase of a set of lantern slides made from Van der Stricht's preparations showing fertilization in *Nereis.*

RESOLUTIONS ADOPTED REGARDING DUTY FREE IMPORTATION OF SCIENTIFIC MATERIALS

The American Society of Zoologists representing the zoological interests of the country, especially from the standpoint of research and instruction in our American colleges and universities, views with much concern the proposals made in the bill H. R. 7785 which provides for an increase of 20 per cent. in the duty on scientific instruments and an increase of 30 per cent. on scientific glassware and in addition repeals section 573 of the tariff act of October 3, 1913, which allows for the duty free importation of such materials by educational institutions.

In view of the fact that the great mass of research in pure science is still carried on by men in our colleges and universities, an increase in the cost of scientific apparatus and equipment is especially to be deplored since even under the present arrangement of low duties and duty free import privileges, the funds at the disposal of our educational institutions are inadequate to provide for the most efficient teaching equipment or to allow for the most effective prosecution of research.

Therefore be it resolved: That the American Society of Zoologists, assembled in annual session, call the attention of Congress to the burden imposed upon the prosecution of educational and research work by the proposed repeal of the privilege of duty free importation of scientific apparatus, chemicals and glassware by educational institutions and respectfully request the continuance of this privilege in proposed tariff legislation.

The American Society of Zoologists also requests the restoration of the privilege of the duty free importation of single copies of scientific books in the English language by members of recognized educational and scientific institutions.

That copies of these resolutions be forwarded to the Congressional Committees concerned, the National Academy of Sciences, the National Research Council and to the executive committee of the American Association for the Advancement of Science and given other proper publicity as the executive committee of the American Society of Zoologists shall direct.

CONCERNING THE PRESERVATION OF WILD LIFE

Whereas: The Ecological Society of America is engaged in attempting to secure the reservation of natural areas, *i.e.,* reserves including the original flora and fauna in an undisturbed state, for research present and future. A standing committee has been listing and describing such areas desirable for reservation, during several years past. The society is now entering on a plan to unite the various groups interested in primeval areas, namely:

1. Investigators in biology, geography, history and art.
2. Sportsmen through their interest in game sanctuaries.
3. Ornithologists through their interest in bird refuges.
4. Wild flower lovers through their interest in primeval areas as seeding centers and preserves.

The purpose of such union of interest will be to secure the preservation of natural areas in state parks, forest preserves, etc., and to secure the creation of more such parks and forest preserves.

Whereas: The number of primeval preserves especially in the eastern states is wholly inadequate for either present or future research purposes and areas from which such preserves may be created are rapidly being destroyed.

Be it resolved: That the American Society of Zoologists indorses the efforts of the Ecological Society of America to secure reserves for research purposes and directs its secretary to forward a copy of this resolution to the division of Biology and Agriculture of the National Research Council.

And further resolved: That the president of the society be directed to appoint a delegate to the Parks Conference to be held in Des Moines, Iowa, January 10, 11 and 12, 1921, said delegate to represent the society in the interest of reserves of primeval conditions for zoological research.

A more complete report of the business transacted together with titles and abstracts of the papers presented and a revised list of members of the society will be found in the *Anatomical Record* for January, 1921.

W. C. Allee,
Secretary-Treasurer

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